Active Project (2015 - 2017)

Compact Sensor for Isotope and Trace Gas Analysis, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

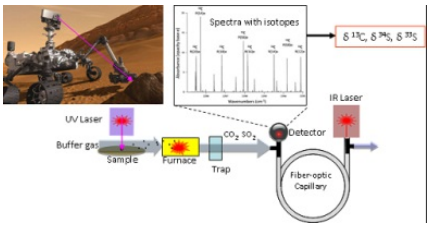
ABSTRACT

We propose to develop and demonstrate a new sensor platform for isotope and trace-gas analysis that is appropriate for future planetary missions. Among other applications, the technology can enable the collection of isotope ratio data in support of the search for evidence of life within the solar system. Current limitations to in-situ isotope measurements will be overcome by utilizing a capillary absorption spectrometer (CAS). This concept enables high precision measurements within the ultra-small volume (~ 0.1 ml) of a hollow fiber optic capillary and has proven to be three orders of magnitude more sensitive than competing sensors. The proposed effort focuses on transitioning the current lab-based technique to a small size, weight, and power (SWaP) device that can be operated unattended. In Phase I, proposed concepts for improving the system performance, reducing the SWaP, and engineering a field-capable device were proven and specific options down selected. Under Phase II, we will fully develop a general prototype sensor platform, which is applicable to a wide range of isotope ratio and trace-gas analysis applications. Specific examples of the utility and versatility of the concept will be demonstrated by using the system as a stand-alone gas sensor, as well as in combination with both a laser ablation sampler and a gas chromatograph. In addition, a dual laser system will be developed to measure both Carbon (C) and Sulfur (S) isotope ratios. The sensitivity afforded by the proposed system would open up remote analysis of smaller samples than ever before measured, which could be a significant development in the search for biosignatures on other planets and near space objects, as well as in the early Earth rock record.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: The isotope and gas sensor resulting from this project will be developed to support



Compact Sensor for Isotope and Trace Gas Analysis

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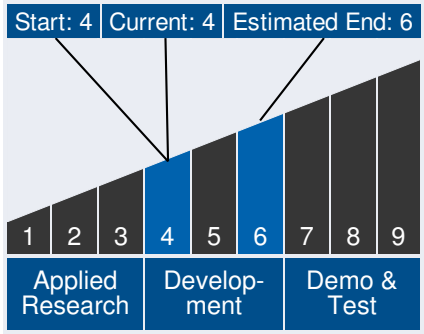
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

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efforts to search for evidence of life on future NASA missions. The research is specifically relevant to NASA Objective 2.3 which is to "Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere," as well as NASA Astrobiology Roadmap Goal 7: "Determine how to recognize signatures of life on other worlds and on Earth." In fact, NASA Astrobiology Roadmap Objective 7.1 is to "Learn how to recognize and interpret biosignatures which, if identified in samples from ancient rocks on Earth or from other planets, can help to detect and/or characterize ancient and/or present-day life." The anticipated technology would also be useful for the exploration of the Moon, asteroids, primitive meteorites, comets, and interplanetary dust particles. The relatively small size of the system will enable it to be inserted into a range of missions including landers and rovers. The capillary absorption spectrometer (CAS) at the heart of the system will also provide a new high precision, ultra-low-volume sensor relevant to a range of other NASA applications. These include water isotope ratio measurements, atmospheric sensing of Earth and other planets, environmental sensing from a small UAV, analysis of soil bacteria related to Carbon cycle, as well as full elemental analysis of various microscopic-sized samples and organisms.

To the commercial space industry:

Potential Non-NASA Commercial Applications: The CAS sensor to be developed under this project will provide an extremely attractive alternative to both isotope ratio mass spectrometers (IRMS) and cavity ring down spectrometers (CRDS). The CAS will be relatively inexpensive, require only picomoles of material, and be much smaller than competing systems. CAS sensors will fill niche markets in forensic analysis, environmental sensing, human breath analysis, and industrial process control. This STTR will lead to a new class of sensors, not just a modification of an existing concept. The resulting ultra-small volume sensors could compete with and complement current commercial sensors, and potentially open up new opportunities to perform real-time, in-situ analysis of trace molecules and stable isotopes

Management Team *(cont.)*

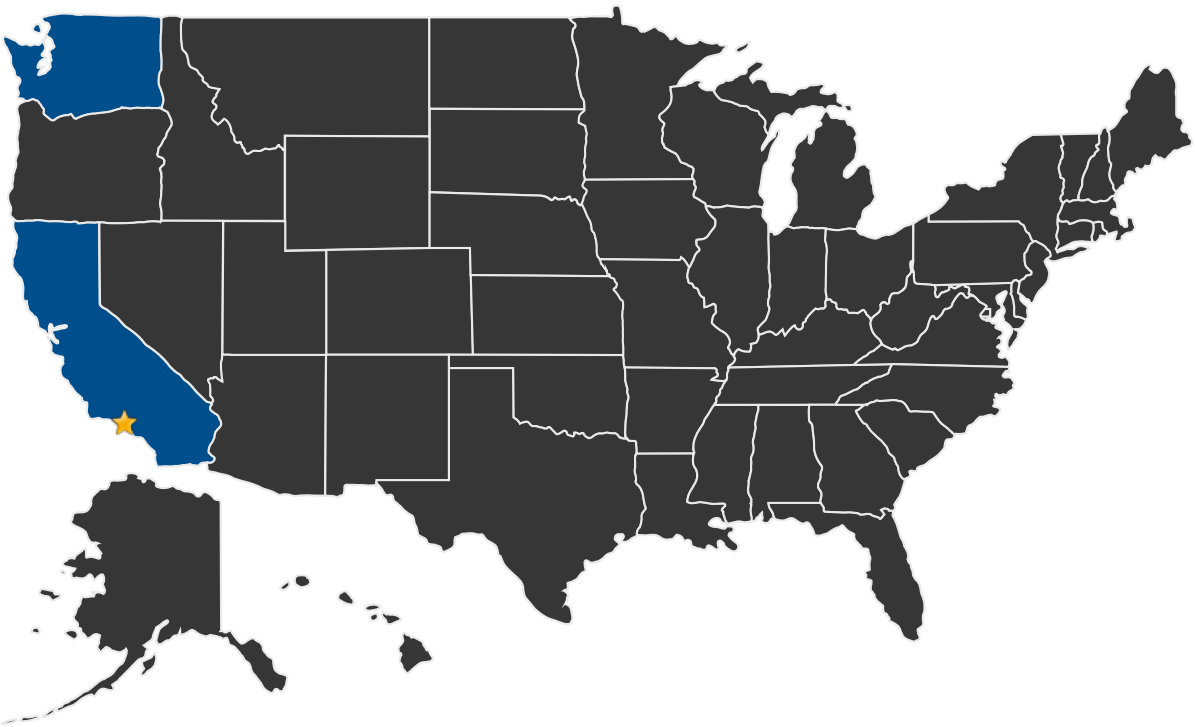
Principal Investigator:
- Jason Kriesel

Technology Areas

Secondary Technology Area:
Science Instruments, Observatories, and Sensor Systems (TA 8)
└ Remote Sensing Instruments and Sensors (TA 8.1)
  └ Optical Components (TA 8.1.3)

in remote and/or sample-limited situations.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Jet Propulsion Laboratory

Other Organizations Performing Work:

- Opto-Knowledge Systems, Inc. (OKSI) (Torrance, CA)
- Pacific Northwest National Laboratory (PNNL) (Richland, WA)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/17712)

DETAILS FOR TECHNOLOGY 1

Technology Title

Compact Sensor for Isotope and Trace Gas Analysis